Claims

[c1] 1. A method, comprising:

conducting a permeable-reactive barrier (PRB) treatment of a contaminated aqueous medium; and

in-well monitoring effectiveness of the PRB treatment.

[c2] 2. The method of claim 1, wherein the in-well monitoring is conducted by at least one well placed up to about 25 feet up-gradient of the PRB and at least one well placed up to about 25 feet down-gradient of the PRB.

[c3] 3. The method of claim 1, wherein the in-well monitoring is conducted by at least one well placed about 1 to about 6 feet up-gradient of the PRB and at least one well placed about 1 to about 6 feet down-gradient of the PRB.

[c4] 4. The method of claim 1, wherein the in-well monitoring is conducted by at least one well placed about 2 to about 4 feet up-gradient of the PRB and at least one well placed about 2 to about 4 feet down-gradient of the PRB.

[c5] 5. The method of claim 1, wherein the in-well monitoring is conducted by a plurality of wells arranged substantially along a transect to a PRB zone.

[c6] 6. The method of claim 1, wherein the in-well monitoring is conducted by a plurality of in-well sensors arranged substantially along a transect to a PRB zone and the transect is defined by a ± 20 feet wide horizontal plane that transcribes at least one up-stream monitoring well and at least one down-stream well at a level that is ± 5 feet of a mid point of each well open screen interval.

[c7] 7. The method of claim 1, wherein the in-well monitoring is conducted by a plurality of in-well sensors arranged substantially along a transect to a PRB zone and the transect is defined by a ± 10 feet wide horizontal plane that transcribes at least one up-stream monitoring well and at least one down-stream well at a level that is ± 3 feet of a mid point of each well open screen interval.

[c8] 8. The method of claim 1, wherein the in-well monitoring is conducted by a

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plurality of in-well sensors arranged substantially along a transect to a PRB zone and the transect is defined by a ± 6 feet wide horizontal plane that transcribes at least one up-stream monitoring well and at least one down-stream well at a level that is ± 1 feet of a mid point of each well open screen interval.

[c9] 9. The method of claim 1, wherein the in-well monitoring is conducted by a plurality of in-well sensors arranged substantially along a transect to a PRB zone, wherein the transect is defined by flow of contaminated aqueous medium.

[c10] 10. The method of claim 1, comprising determining flow of contaminated aqueous medium up-gradient, down-gradient and transecting a PRB zone, placing monitoring wells along the flow of contaminated medium and conducting the in-well monitoring with the monitoring wells.

[c11] 11. The method of claim 1, comprising determining flow of contaminated aqueous medium up-gradient, down-gradient and transecting a PRB zone, placing monitoring wells along the flow of contaminated medium and conducting the in-well monitoring with the monitoring wells, wherein at least one monitoring sensor is placed in-well up-gradient of the PRB zone.

[c12] 12. The method of claim 1, comprising determining flow of contaminated aqueous medium up-gradient, down-gradient and transecting a PRB zone, placing monitoring wells along the flow of contaminated medium and conducting the in-well monitoring with the monitoring wells, wherein at least one monitoring sensor is placed in-well down-gradient of the PRB zone.

[c13] 13. The method of claim 1, comprising determining flow of contaminated aqueous medium up-gradient, down-gradient and transecting a PRB zone, placing monitoring wells along the flow of contaminated medium and conducting the in-well monitoring with the monitoring wells, wherein at least one monitoring sensor is placed in-well within the PRB zone.

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[c14] 14. The method of claim 1, comprising determining flow of contaminated aqueous medium up-gradient, down-gradient and transecting a PRB zone, placing monitoring wells along the flow of contaminated medium and

conducting the in-well monitoring with the monitoring wells, wherein at least one monitoring sensor is placed in-well up-gradient of the PRB zone, at least one monitoring sensor is placed in-well down-gradient of the PRB zone and ate least one monitoring sensor is placed within the PRB zone.

[c15] 15. The method of claim 1, comprising monitoring effectiveness by measuring at least one of pH, oxidation-reduction potential and specific conductivity.

[c16] 16. The method of claim 1, comprising determining nature, extent and velocity of a plume of contaminated aqueous medium and conducting the PRB treatment of the contaminated aqueous medium.

[c17] 17. The method of claim 1, comprising selecting and providing a barrier zone of reactive material and conducting the PRB treatment with the barrier zone.

[c18] 18. The method of claim 17, comprising excavating a trench suitable for receiving the reactive material and placing the reactive material within the trench to provide the barrier zone.

[c19] 19. The method of claim 18, comprising locating the trench so that the reactive material therein lies in the path of a plume of the contaminated aqueous medium.

[c20] 20. The method of claim 1, wherein the in-well monitoring is accomplished with a sensor containing monitoring well located in the vicinity of a PRB zone.

[c21] 21. The method of claim 1, wherein the in-well monitoring is accomplished with monitoring wells placed up-gradient and down-gradient of a PRB zone.

[c22] 22. The method of claim 1, wherein the in-well monitoring is accomplished with a monitoring well placed within the reactive material of a PRB zone.

[c23] 23. A method of treating a contaminated groundwater, comprising:

sensing a characteristic of the contaminated groundwater with a sensor placed in at least one well emplaced substantially along a transect of a longitudinal axis of a PRB zone; and

remotely monitoring the sensing to determine effectiveness of a

remediation treatment of the groundwater.

[c24] 24. The method of claim 23, wherein a characteristic of the contaminated groundwater is sensed with a sensor placed within the well.

[c25] 25. The method of claim 23, wherein a characteristic of the contaminated groundwater is sensed with a sensor placed up-gradient and a sensor placed down-gradient of the PRB.

[c26] 26. The method of claim 23, wherein the sensors are placed substantially along a transect to a PRB zone and the transect is defined by a ± 20 feet wide horizontal plane that transcribes at least one up-stream monitoring well and at least one down-stream well at a level that is ± 5 feet of a mid point of each well open screen interval.

[c27] 27. The method of claim 23, wherein the sensors are placed substantially along a transect to a PRB zone and the transect is defined by a ± 10 feet wide horizontal plane that transcribes at least one up-stream monitoring well and at least one down-stream well at a level that is ± 3 feet of a mid point of each well open screen interval.

[c28] 28. The method of claim 23, wherein the sensors are placed substantially along a transect to a PRB zone and the transect is defined by a ± 6 feet wide horizontal plane that transcribes at least one up-stream monitoring well and at least one down-stream well at a level that is ± 1 feet of a mid point of each well open screen interval.

[c29] 29. The method of claim 23, wherein a characteristic of the contaminated groundwater is sensed with a sensor placed up-gradient of the PRB, a sensor placed down-gradient of the PRB and a sensor placed within the PRB.

[c30] 30. The method of claim 23, comprising adjusting the treatment of contaminated groundwater according to the monitoring.

[c31] 31. The method of claim 23, wherein the monitoring comprises sensing a contaminant and transmitting a signal concerning the contaminant to a data collector.

[c32] 32. The method of claim 31, wherein the data collector collects the signal and transmits information concerning the contaminant derived from the signal.

[c33] 33. The method of claim 32, wherein the collector transmits the information to a remote monitor.

[c34] 34. The method of claim 33, wherein the information is transmitted over a web connection, phone modem connection, radio connection, network connection, wireless connection, cellular connection, satellite connection, Internet connection or combinations thereof.

[c35] 35. The method of claim 33, further comprising outputting a contaminant report from the remote monitor.

[c36] 36. A method of monitoring a PRB treatment of a contaminated aqueous medium, comprising:

determining flow of the contaminated aqueous medium across a PRB zone to define a transect of the zone from an up-gradient to the zone across the zone to a down-gradient to the zone;

emplacing a monitoring well up-gradient to the zone and a monitoring well down-gradient to the zone substantially along the transect; and

evaluating the performance of the PRB treatment with the wells.

[c37] 37. The method of claim 36, additionally comprising emplacing a monitoring well within the zone substantially along the transect.

[c38] 38. The method of claim 36, wherein the transect is a straight line between flow of the contaminated aqueous medium at an up-gradient location to flow of the contaminated aqueous medium at a down-gradient location.

[c39] 39. The method of claim 36, wherein the transect is defined by a ± 20 feet wide horizontal plane that transcribes at least one up-stream monitoring well and at least one down-stream well at a level that is ± 5 feet of a mid point of each well open screen interval.

[c40] 40. The method of claim 36, wherein the transect is defined by a ± 10 feet wide horizontal plane that transcribes at least one up-stream monitoring well and at

least one down-stream well at a level that is ± 3 feet of a mid point of each well open screen interval.

[c41] 41. The method of claim 36, wherein the transect is defined by a ± 6 feet wide horizontal plane that transcribes at least one up-stream monitoring well and at least one down-stream well at a level that is ± 1 feet of a mid point of each well open screen interval.

[c42] 42. A method of evaluating performance of a PRB zone, comprising

emplacing a sensor in a vicinity of the PRB zone; and

measuring at least one of pH, oxidation-reduction potential and specific conductivity with the sensor.

[c43] 43. The method of claim 42, comprising measuring pH, oxidation-reduction potential and specific conductivity with a plurality of sensors.

[c44] 44. A system comprising:

a PRB zone to treat a contaminated groundwater;

an in-well sensor located within a gradient of the contaminated groundwater or within the PRB zone to sense a characteristic of the groundwater.

[c45] 45. The syst em of claim 44, additionally comprising a monitor to receive information concerning the characteristic from the sensor.

[c46] 46. The syst em of claim 45, wherein the monitor is situated at a location remote from the PRB zone.

[c47] 47. The syst em of claim 44, comprising at least one well placed up to about 25 feet up-gradient of the PRB and at least one well placed up to about 25 feet down-gradient of the PRB.

[c48] 48. The system of claim 44, comprising at least one well about 1 to about 6 feet up-gradient of the PRB and at least one well placed about 1 to about 6 feet down-gradient of the PRB.

[c49] 49. The system of claim 44, comprising at least one well placed about 2 to

about 4 feet up-gradient of the PRB and at least one well placed about 2 to about 4 feet down-gradient of the PRB.

[c50] 50. The system of claim 44, comprising a plurality of in-well sensors placed within the gradient of the contaminated groundwater or within the PRB zone.

[c51] 51. The system of claim 50, wherein the sensors of the plurality are located along a transect of the PRB zone.

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[c52] 52. The system of claim 51, wherein the transect is defined by a ± 20 feet wide horizontal plane that transcribes at least one up-stream monitoring well and at least one down-stream well at a level that is ± 5 feet of a mid point of each well open screen interval.

[c53] 53. The system of claim 51, wherein the transect is defined by a ± 10 feet wide horizontal plane that transcribes at least one up-stream monitoring well and at least one down-stream well at a level that is ± 3 feet of a mid point of each well open screen interval.

[c54] 54. The system of claim 51, wherein the transect is defined by a ± 6 feet wide horizontal plane that transcribes at least one up-stream monitoring well and at least one down-stream well at a level that is ± 1 feet of a mid point of each well open screen interval.

[c55] 55. The system of claim 44, further comprising a transmitter associated with a sensor to transmit a signal concerning the characteristic.

[c56] 56. The system of claim 55, further comprising a collector to receive the signal from the transmitter.

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57. ~~The system of claim 57,~~ wherein the collector is capable of transmitting a signal concerning the characteristic to a ~~monitor~~.

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[c58] 58. The system of claim 57, further comprising a communication ~~link that~~ interconnects the data collector and the ~~monitor,~~ the communication link capable of transmitting ~~the~~ signal to enable a user at the monitor to obtain ~~information~~ concerning the contaminant.

[c59] 59. The system of claim 59, wherein the communication link comprises a web connection.

[c60] 60. The system of claim 59, wherein the communication link comprises a network.

[c61] 61. The system of claim 59, wherein the communication link comprises a phone modem connection, radio communication connection, network communication connection, wireless communication system connection, cellular communication connection, satellite communication connection, web connection, Internet connection or combinations thereof.

[c62] 62. The system of claim 59, further comprising a two-way communicator between the collector and the sensor to permit selection, activation, de-activation, modification, fine-tuning, manipulation or resetting of the sensor.

[c63] 63. The system of claim 59, wherein the sensor comprises a vapor sensor, chemical sensor, fiber optics sensor, acoustic wave sensor solid-state sensor, metal oxide sensor, an electrochemical sensor or combinations thereof.

[c64] 64.The system of claim 44, comprising a plurality of sensors emplaced in respective plurality of wells arranged substantially along a transect to the PRB zone.

[c65] 65. The system of claim 44, comprising a plurality of sensors emplaced in respective plurality of wells arranged substantially along a longitudinal axis of the PRB zone facing flow of the contaminated aqueous medium.

[c66] 66.A system comprising:

a PRB zone to treat a contaminated groundwater;

a sensor located substantially along a transect of flow of the contaminated groundwater from an up-gradient location, across the PRB zone to a down-gradient location.